NBER WORKING PAPER SERIES

HALLOWEEN, ADHD, AND SUBJECTIVITY IN MEDICAL DIAGNOSIS

Christopher Worsham
Charles Bray
Anupam Jena

Working Paper 33232
http://www.nber.org/papers/w33232

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
December 2024

Jena reports receiving (in the last 36 months) income unrelated to this work from Sirius XM, New York Times, Wall Street Journal, Los Angeles Times, the Harry Walker Agency, AAE Speakers Bureau, and Analysis Group. Worsham received support from the Agency for Healthcare Research and Quality (grant #K08HS029197) and income unrelated to this work from Alosa Health, Analysis Group, Atheneum, Berkshire Hathaway Home Companies, Chronius, FVC Health, GLG, Guidepoint, NuvoAir, Ogilvy, Philips, Simbo, Tell Health, Doubleday Books, Substack, New York Times, and Wall Street Journal. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Halloween, ADHD, and Subjectivity in Medical Diagnosis
Christopher Worsham, Charles Bray, and Anupam Jena
NBER Working Paper No. 33232
December 2024
JEL No. I1, I10, I12

ABSTRACT

The practice of medicine relies on accurate diagnosis. However, the diagnosis of many medical conditions involves assessments that invite varying degrees of subjectivity. External and arbitrary factors can influence physicians' diagnostic assessments in conditions ranging from heart attacks to neurodevelopmental conditions like attention deficit hyperactivity disorder (ADHD). Quantifying this subjectivity is challenging, however, particularly for neurodevelopmental and psychiatric conditions where subjective assessments of behavior are common and important. Halloween, a holiday characterized by excitement among children, could present a natural experiment to study subjectivity in diagnosis, if any ensuing behavioral changes influence diagnosis rates of ADHD. Using data on over 100 million physician office visits, we compared ADHD diagnosis rates, by day, among children seen by physicians in the 10 weekdays surrounding seven Halloween holidays. The rate of new ADHD diagnosis was 62.7 per 10,000 child-visits on Halloween, compared with 55.1 during surrounding weekdays, a 14% increase. There were no increases in diagnoses of several neuropsychiatric disorders with diagnostic criteria that are less focused on hyperactive behavior. Our findings highlight subjectivity in ADHD diagnosis and support the need to consider external factors that may influence diagnosis.

Christopher Worsham
Harvard Medical School
Department of Health Care Policy
180 Longwood Ave.
Boston, MA 02115
cworsham@mgh.harvard.edu

Charles Bray
Harvard Medical School
Department of Health Care Policy
180 Longwood Avenue
Boston, MA 02115
bray@hcp.med.harvard.edu

Anupam Jena
Department of Health Care Policy
Harvard Medical School
180 Longwood Avenue
Boston, MA 02115
and NBER
jena@hcp.med.harvard.edu

1. Introduction

The practice of medicine fundamentally relies on accurate diagnosis to inform treatment decisions. Nevertheless, the National Academy of Medicine estimates that most people will experience a diagnostic error at some point in their lifetime (National Academy of Medicine 2015). While diagnosis of some conditions relies on more objective criteria obtained from laboratory studies, imaging, and physiologic assessments, other diagnoses (e.g., psychiatric and neurodevelopmental conditions) rely more heavily on reporting and observation of symptoms or behaviors which involve some degree of subjectivity. Though necessary for diagnosis, such subjectivity opens the door for cognitive biases and influence from external factors to influence medical decision making (Layton et al. 2018; Worsham et al. 2021; Olenski et al. 2020; Coussens 2018). Moreover, quantifying the impact of subjectivity in diagnosis is challenging.

Attention deficit hyperactivity disorder (ADHD) is a common diagnosis among children, diagnosed in approximately 1 in 11 children aged 3 to 17 years (Bitsko et al. 2022). Current guidelines recommend that any child between age 4 and 18 who presents with academic or behavioral problems and symptoms of inattention, hyperactivity, or impulsivity be evaluated for ADHD (Wolraich et al. 2019). The rate of ADHD diagnosis has increased over the past several decades, raising simultaneous concerns that ADHD may sometimes be over-diagnosed and over-treated – particularly in milder or borderline cases – while, at the same time, under-diagnosed and under-treated in certain populations (Xu et al. 2018; Kazda et al. 2021a; Furzer, Dhuey, and Laporte 2022; Coker et al. 2016; Adamis et al. 2022).

Applying behavior-based diagnostic criteria (American Psychiatric Association 2013) for ADHD inherently involves some degree of subjectivity on the part of a teacher, parent, or clinician when determining whether a child's behavior is within or outside the norm. While important diagnostic criteria exist, the subjectivity involved in diagnosis is one reason why concerns have been raised about both over- and under-diagnosis. Prior research has also demonstrated that diagnosis of ADHD can be influenced by seemingly-unrelated external factors, such as a child's age relative to their peers at school (Layton et al. 2018; Elder 2010; Evans, Morrill, and Parente 2010; Whitely et al. 2019; Schwandt and Wuppermann 2016). Other external factors have been shown to influence diagnosis and treatment in many health care settings, such as adults being evaluated for myocardial infarction (Coussens 2018; Olenski et al. 2020) or children and adolescents across a variety of settings and conditions, including ADHD (Layton et al. 2018; Haeck et al. 2023; Furzer, Dhuey, and Laporte 2022; Worsham, Woo, and Jena 2020; Worsham et al. 2021; Elder 2010; Evans, Morrill, and Parente 2010; Whitely et al. 2019; Schwandt and Wuppermann 2016).

While diagnostic criteria such as those outlined in the *Diagnostic Statistical Manual of Mental Disorders (*American Psychiatric Association 2013*)* (DSM) aim to permit clinicians to establish diagnoses from objective criteria, diagnosis of DSM conditions inherently involves subjective assessments of behavior by diagnosticians (Fuchs 2010; Nordgaard, Sass, and Parnas 2012). To the extent such conditions are, by their nature, difficult to study, it is even more challenging to examine the role of diagnostic subjectivity and the factors that influence it. Identifying situations in which behavior may plausibly change due to external factors offers an opportunity to quantify one way in which subjectivity can influence diagnosis.

In this study, we take advantage of the behavioral changes that may be brought on by Halloween—an exogenous source of behavioral variation in the pediatric diagnostic setting—to quasi-experimentally examine patterns of ADHD diagnosis and treatment in the weeks surrounding Halloween. The anticipation and excitement of Halloween-day activities, like wearing a costume and collecting candy, may influence behavior—particularly as it pertains to signs of ADHD—compared with other days. Halloween therefore presents a novel opportunity to study fundamental questions of the role of diagnostic subjectivity in ADHD. Although research into the effects of Halloween on health outcomes is very limited, Halloween has been associated with behavior changes leading to increased risk of injuries among children, adolescents, and young adults (Zhang and Khan 2020; Centers for Disease Control and Prevention 1997; Staples, Yip, and Redelmeier 2019).

We hypothesized that Halloween-related changes in behavior may influence the diagnosis and treatment of childhood ADHD, since the behavior of children excited about the holiday may be interpreted as signs or symptoms of ADHD. While guideline-based diagnosis of ADHD in children looks for patterns of behavior within information provided by parents/guardians, teachers and school personnel, or other clinicians (Wolraich et al. 2019), encounters with physicians provide "snapshots" into those behaviors and there is always a specific moment in time in which a diagnosis is formally made. Snapshots of behaviors consistent with ADHD—including fidgetiness, running around, or difficulty staying quiet (American Psychiatric Association 2013)—observed in an office setting could reinforce a physician's underlying clinical suspicion and solidify a diagnosis in that moment. If so, behavioral changes observed on Halloween, if present, could lead to greater diagnoses: diagnoses that would not have otherwise been made or would have been made later. This increase could reflect overdiagnosis or appropriate diagnosis (e.g., if excitement related to Halloween is one way in which ADHD symptoms manifest for a child who was previously undiagnosed). Evidence of either case occurring would serve to highlight the role subjectivity and external changes affecting the diagnostic environment may play in diagnosis.

Analyzing data from over 100 million physician office visits, we found a 14% increase in the rate of diagnosis of ADHD among children seen on Halloween compared to the surrounding weekdays despite these children having similar characteristics and estimated risk of ADHD diagnosis. Meanwhile, we saw no increases in diagnoses of several neuropsychiatric conditions with diagnostic criteria that are less focused on hyperactive behavior, nor did we observe increases in the average complexity of office visits on Halloween. Both findings suggest that Halloween-day increases in ADHD diagnosis are not due to unobserved factors that raise the probability of ADHD diagnosis on Halloween. For example, if physician office visits on Halloween are less desirable, parents who are particularly concerned that their child may have ADHD could schedule appointments for their children on Halloween day, in order to be seen earlier. However, this selection bias would presumably also apply to other neuropsychiatric conditions or to the overall complexity of children seen on Halloween, yet no Halloween-day changes were observed for either. There were also no differences in ADHD diagnosis rates on Valentine's Day—another candy-centric holiday, but one that is less exciting for children, suggesting a Halloween-specific effect. We also observed no differences in medication prescription patterns for ADHD diagnoses made on Halloween, suggesting these cases were managed similarly.

Put together, our findings highlight subjectivity in ADHD diagnosis and support the need to consider external factors that may influence diagnosis. Using a novel approach to quasi-experimentally quantify the role that subjectivity can play in diagnosis of neuropsychiatric disease, our study adds to a growing body of evidence demonstrating the role of diagnostic subjectivity across a wide array of patient populations and medical conditions.

2. Data

Data Sources

Data were obtained from the MarketScan Research Database (IBM, Armonk, NY), a database of insurance claims which in its most recent year currently available, 2021, contains information on tens of millions of Americans with employer-sponsored health insurance. This database has previously been used to study patterns of childhood ADHD diagnosis (Layton et al. 2018; Visser et al. 2016; Chang et al. 2017). Demographic data for median household income and percentage of residents with a college degree in a given metropolitan statistical area (MSA) were obtained from the U.S. Bureau of Economic Analysis (U.S. Bureau of Economic Analysis 2011) and U.S. Census Bureau (U.S. Census Bureau 2011), respectively. Weather data were obtained from the U.S. National Oceanic and Atmospheric Administration Global Historical Climatology Network (National Oceanic and Atmospheric Administration 2024).

Study Population

The study cohort comprised enrollees aged 5 to 18 years at the time of weekday office visits in the years 2011-2014 and 2016-2018, who were continuously enrolled in insurance for 6 or more months leading up to and including the date of office visit. The year 2015 was not included since Halloween fell on a Saturday (notably, 2016 was included since it was a leap year and Halloween fell on Monday rather than Sunday). To focus on new diagnoses of ADHD, we excluded children who had had an ADHD diagnosis claim or claim for ADHD treatment prior to their office visit. For children first diagnosed with and/or treated for ADHD during the study period, all subsequent office visits for that child were excluded.

Study Measures and Covariates

We assessed whether the rate of initial ADHD diagnosis on Halloween differed from the rate measured in the ±10 weekdays immediately surrounding October 31st in the years studied. We selected the years 2011 through 2018, excluding 2015, as these were years in which Halloween occurred on a weekday and for which the MarketScan commercial insurance claims database had a family identifier variable available in order to measure the family characteristics of the study population. Weekends were excluded entirely from the analysis, as there are far fewer office visits made on these days, and patients seen on these days could be different in observed and unobserved characteristics that would confound the relationship between day relative to Halloween and rate of ADHD diagnosis.

Clinical and health care utilization characteristics of children and their family members, as well as data on office visits, were obtained from insurance claims in the MarketScan database. Comorbid medical conditions were defined using the Elixhauser comorbidity software (Healthcare Cost and Utilization Project 2017). Visit complexity was defined by Current Procedural Terminology (CPT) codes 99211-99215.

The primary outcome was a diagnosis of ADHD as defined by the International Classification of Diseases, 9th Revision (ICD-9), code 314.01 (attention deficit disorder with hyperactivity) or 314.00 (attention deficit disorder without hyperactivity) and 10th Revision (ICD-10), codes F90.0 - F90.9 (inattentive type, hyperactive type, combined, other, and unspecified type). Patients were defined to be newly diagnosed with ADHD at an office visit if the diagnosis code was present for the first time on any claim (see **Table 1** for additional details). Importantly, we only included ICD codes suggestive of a diagnosis of ADHD, i.e., we did not include codes suggestive of evaluation or screening only.

Among children newly diagnosed with ADHD, a secondary outcome was prescription drug treatment for ADHD with a prescription fill for a stimulant drug within 14 days of the visit, a binary outcome. For those who received prescription drug treatment, we also examined the intensity of treatment by measuring the total number of days of ADHD medication supplied to each child throughout all years of the study period.

Primary Analyses

Characteristics of patients seen on Halloween were compared with those seen in the ±10 surrounding weekdays using standardized mean differences (Cochrane Collaboration 2020), an analysis conducted to assess whether children seen on Halloween may systematically differ on observable characteristics, including a family history of ADHD, which if so would raise concerns of unmeasured confounding. Relatedly, levels of visit complexity, assessed by evaluation and management billing codes, were also compared between Halloween and non-Halloween days to assess whether more complex visits occurred on Halloween.

We then conducted an event study analysis. Specifically, we used multivariable logistic regression to measure our primary outcome of initial ADHD diagnosis during an office visit for children aged 5 to 18 years, where covariates included indicator variables for each day relative to Halloween for the ±10 surrounding weekdays, a single indicator for all other dates outside of this time window, and day-of-week indicators (Monday through Friday). Other covariates included separate continuous variables for log-transformed number of office visits, log-transformed number of ED visits, and log-transformed number of hospitalizations for the child that year, as well as these same measures averaged and log-transformed for each of the child's siblings and parents; the total number of Elixhauser comorbidities of the child and the average number of Elixhauser comorbidities for the child's siblings and the child's parents; and count of siblings with ADHD and count of parents with ADHD. We then estimated this model and plotted adjusted rates of ADHD diagnosis by day relative to Halloween, an event-study depiction.

In addition to this approach, we measured overall differences in ADHD diagnosis between Halloween and non-Halloween days (i.e., combining the ±10 weekdays immediately surrounding Halloween). Specifically, we generated an alternate specification of the regression model which included a binary covariate equal to one for Halloween day and zero for all other non-Halloween days; other covariates remained the same.

We then conducted several subgroup analyses. First, we repeated the primary analyses stratified by child age and sex to evaluate for possible differences across these subgroups in the likelihood of ADHD diagnosis on Halloween. In addition, we conducted a subgroup analysis in children who belonged to a family where at least one covered family member was diagnosed with diabetes, under the hypothesis that the excitement associated with candy intake may be lower in households where candy intake might plausibly be more restricted (i.e., households with someone with diabetes). Finally, we performed an exploratory analysis stratified by weather conditions (at the level of the MSA-day) to evaluate whether particularly bad weather - e.g., rainfall or low temperatures on a given Halloween – may mitigate the potential relationship between Halloween and ADHD diagnosis by dampening excitement associated with the holiday.

Additional Analyses

We conducted several additional analyses. First, to assess for potential differences in baseline rates of ADHD diagnosis among children seen on Halloween versus other days, an additional regression model estimated the probability of ADHD diagnosis based on the same covariates in the primary model but without relative day indicators. Predicted rates of ADHD diagnosis were then computed for each child visit and the average predicted rate of ADHD diagnosis was plotted by relative day, to examine whether this rate varied between Halloween and non-Halloween days. We hypothesized that predicted rates of ADHD, estimated from baseline child and family characteristics, would not vary between Halloween and non-Halloween days, consistent with a natural experiment.

Second, to more closely examine the nature of ADHD diagnoses made on Halloween, we investigated differences in the probability of ADHD treatment and duration (measured by the total number of days of ADHD medication supplied throughout all years of the study period) between children newly diagnosed with ADHD during office visits on Halloween compared with the surrounding weekdays. To the extent that some children diagnosed with ADHD on Halloween may otherwise not have been diagnosed if seen by a physician on a different day, the likelihood or duration of medication use may be lower among Halloween-related diagnoses.

Third, it is possible that rates of ADHD diagnoses may be higher on Halloween due to particularly concerned parents seeking medical appointments even on a “holiday” like Halloween. If physician appointments on Halloween are otherwise less desirable to parents and availability is greater, rates of ADHD diagnoses may be elevated on Halloween due to selection bias in the types of children who are seen on this day. To assess this possibility, in addition to predicting ADHD diagnosis rates based on baseline characteristics as described above, we evaluated diagnosis patterns of several neuropsychiatric disorders with diagnostic criteria that are less focused on hyperactive behavior but nonetheless may be elevated if selection bias is present in which types of children are seen in physicians' offices on Halloween. We repeated our analysis using new diagnoses of autism or Asperger's syndrome, eating disorders, or personality disorders (see **Table 1** for diagnosis codes).

Fourth, to further assess whether our findings may be affected by selection bias among children seen in physicians' offices on a holiday, we repeated our analysis around Valentine's Day (February 14^{th}), another holiday associated with candy but generally less excitement for young children compared with Halloween.

Fifth, to determine whether any pattern that we observed may be due to chance (e.g., due to short-term temporal trends unrelated to Halloween), we performed a simulation by drawing, with replacement, 1,000 randomly selected month-day combinations between January 15 and December 15 that were weekdays; the primary analysis was then repeated surrounding the randomly selected month-day combinations, rather than October 31^{st}, as day 0.

The study was approved by the institutional review board at Harvard Medical School.

3. Results

Our study included 114,951,583 child-visits over 2011-2018 excluding 2015, for 13,435,055 unique enrollees aged 5-18 with no previous claim for ADHD diagnosis or treatment at the time of their visit. This included 11,167,306 child-visits on Halloween or the ±10 surrounding weekdays.

The average age of children, across all office visits in our sample, was 11.7 years (s.d. 4.1 years) and 52.9% (5,906,210/11,167,306) of visits were for boys. Overall, 7.1% (789,081/11,167,306) of visits were for children who had another sibling or parent with a prior diagnosis of ADHD. Children seen in physicians' offices on Halloween were similar to those seen on non-Halloween days. Specifically, there were no significant differences between children with office visits on Halloween days and those with office visits in the ±10 surrounding weekdays in observable characteristics including comorbid disease, age and sex, parental and sibling chronic disease (including prior history of ADHD), and healthcare utilization across outpatient and inpatient settings (**Table 2**). There were also no meaningful differences in the billed level of complexity of visits on Halloween compared to the surrounding weekdays (**Figure 1**).

ADHD Diagnosis

The overall adjusted rate of new ADHD diagnosis associated with a visit on Halloween was 62.7 per 10,000 child-visits compared to 55.1 per 10,000 child-visits in the ±10 surrounding weekdays, corresponding to a 14% increase (adjusted odds ratio (OR) of Halloween vs. all ±10 surrounding weekdays 1.14, 95% confidence interval [1.09-1.19]; **Figure 2**).

Halloween day differences were present after stratification by age group (OR for Halloween vs. ±10 surrounding weekdays for children aged 5-11 years 1.11 [95% CI, 1.05-1.18], OR for ages 12-18 1.20 [95% CI, 1.13-1.26]; **Figure 2** and **Table 3**) and sex (OR for males 1.10 [95% CI, 1.05-1.16], OR for females 1.19 [95% CI, 1.11-1.27]; **Figure 2** and **Table 3**), and among children in families where no family member nor the child had diabetes (OR 1.14 [95% CI, 1.09-1.19], **Figure 3** and **Table 3**). There was no statistically significant increase in Halloween-related ADHD diagnosis among children in households where at least one family member carried a diagnosis of diabetes (OR 1.13 [95% CI, 1.00-1.28]), however the estimated OR was similar in magnitude and not statistically significantly different from households in which no member had diabetes. There were no meaningful differences in the magnitude of

Halloween day differences on days in the highest tercile versus lowest tercile of historic temperature or on days with above versus below median historic precipitation (**Figure 3** and **Table 3**).

Additional Analyses

To further evaluate whether children seen on Halloween were systematically different in baseline rates of ADHD diagnosis than those seen on the surrounding weekdays, we generated a regression model that did not include Halloween relative day indicators. There were no meaningful differences in predicted rates of ADHD diagnosis between Halloween and the surrounding days (**Figure 4**), suggesting that patients seen in physicians' offices on Halloween were not at systematically different at baseline.

Similarly, when our analysis was repeated using several neuropsychiatric diagnoses as the outcomes – a falsification analysis designed to assess whether children with greater baseline rates of neuropsychiatric conditions may be more likely to be brought to physicians' offices on Halloween by particularly concerned parents – there were no significant differences in diagnosis rates of autism or Asperger's syndrome, eating disorder, or personality disorder on Halloween compared with the surrounding weekdays (**Figure 5**). Moreover, when estimating a model of ADHD diagnosis that compared randomly chosen "placebo" dates (in lieu of Halloween) with surrounding dates or that compared ADHD diagnosis on Valentine's Day compared with surrounding days, there were no differences in the adjusted rate of ADHD diagnosis between these dates and the surrounding weekdays (**Figure 6** and **Figure 7**), suggesting a Halloween-specific phenomenon.

Finally, among patients diagnosed with ADHD, there were no meaningful differences in the adjusted rate of ADHD medication use between those diagnosed on Halloween or surrounding weekdays, nor were there differences in the duration of treatment among those prescribed medication (**Figure 8**), suggesting that ADHD diagnoses made on Halloween were pharmacologically managed similarly to those made on surrounding weekdays.

4. Discussion

Using large national U.S. data, we found that among children aged 5 to 18 years, those with a doctor's visit on Halloween were significantly more likely to be newly diagnosed with ADHD compared to those with visits on the surrounding weekdays. Clinical and family characteristics of children seen on Halloween were similar to those seen on surrounding weekdays. Meanwhile, there were no increases in diagnosis of several neuropsychiatric conditions or in the overall clinical complexity of children seen on Halloween, arguing against the possibility that our findings were explained by selection bias in terms of which children receive evaluation for ADHD on Halloween. There were also no differences in ADHD diagnoses on Valentine's Day or randomly selected dates.

The results of this study suggest Halloween-induced changes in the diagnostic environment for children with possible ADHD. Halloween is an exciting holiday for kids, who traditionally dress in costume, perhaps adopt a different persona, go door-to-door in the evening seeking treats from their neighbors, or attend a party. While sugar intake (i.e., a "sugar rush") is also a possible mediator, some evidence suggests that consumption of high-sugar foods may not induce behavioral changes, including among children with ADHD, but this evidence is limited and therefore the possibility remains (Wolraich et al. 1994; Wolraich, Wilson, and White 1995;

Mantantzis et al. 2019; Wender and Solanto 1991; Milich and Pelham 1986). Many adults, including clinicians working in pediatric offices, also enjoy participating in the excitement of the day, such as by decorating or donning costumes themselves, in ways that may influence a child's behavior or their own diagnostic behaviors. Our study suggests that collectively, Halloween-day differences in care—including differences in behavior on the part of patients and/or health care providers, as well as differences in the clinical environment—may influence diagnosis of ADHD. More generally, our study illustrates how changes in behaviors observed by clinicians and brought on by external factors, like Halloween, could offer a novel opportunity to study subjectivity in medical diagnosis.

ADHD, like other neuropsychiatric or neurodevelopmental conditions, is diagnosed based on an assessment of behavioral patterns reported to and observed by clinicians. Since clinical encounters offer a brief snapshot into a patient's symptoms or behaviors outside of the clinical setting, our findings demonstrate how differences in behavior during those "snapshots" could influence diagnosis. In particular, diagnosticians who are charged with assessing a pattern of behavior primarily occurring *outside* of the health care setting examine their patients *inside* a clinical environment, where direct observation may sway subjective diagnostic assessments for patients who happen to be examined in different contexts, such as on Halloween.

While formal criteria exist for the diagnosis of ADHD, any behavioral assessment inherently involves some degree of subjectivity—no two physicians would make the same diagnoses 100% of the time. This study therefore adds to the growing literature demonstrating that external factors, including a patient's age relative to their classmates, specifically influence the diagnosis of ADHD (Layton et al. 2018; Elder 2010; Evans, Morrill, and Parente 2010; Whitely et al. 2019; Schwandt and Wuppermann 2016). This and other studies also demonstrate that the context in which individuals are evaluated, whether it be in a classroom compared with older peers or in periods or settings where excitement is greater, may influence the likelihood of an ADHD diagnosis being made. ADHD diagnoses can have long-lasting impacts on medical, educational, and social outcomes later in life (Arnold et al. 2020; Shaw et al. 2012; Volkow and Swanson 2013), making avoiding both over- and underdiagnosis – as well as over- and undertreatment – paramount.

Additional diagnoses of ADHD made on Halloween are likely among patients for whom behaviors consistent with ADHD had previously been identified but not yet acted upon. It remains unclear whether Halloween-induced changes lead to overdiagnosis of patients who do not truly have ADHD or whether behavioral changes observed on Halloween have diagnostic value to clinicians and lead to fewer missed true ADHD diagnoses. For example, if excitement related to Halloween is one way in which the symptoms of ADHD manifest for a child who was previously undiagnosed, a new diagnosis (even if made on Halloween) may be appropriate. Put differently, a visit to a physician on Halloween may serve as a "stress test" that uncovers or clarifies a child's underlying diagnosis of ADHD, much like stress testing is used to diagnose ischemic heart disease (e.g., exercising on a treadmill while the heart is monitored by an EKG to evaluate for ischemic changes). This scenario would raise concerns, however, of why a physician office visit on Halloween is what is required to make the diagnosis. Importantly, while prior studies suggest both over- and under-diagnosis of ADHD may occur in various settings and within differing populations (Kazda et al. 2021b; Manos, Giuliano, and Geyer 2017; Morgan et al. 2014; Xu et al. 2018; Kazda et al. 2021a; Furzer, Dhuey, and Laporte 2022; Coker et al. 2016; Adamis et al. 2022), our study cannot distinguish between these two possibilities. Nonetheless, our study highlights the role of subjectivity in ADHD diagnosis by examining how excited behavior that is culturally normal for the holiday may influence the likelihood or timing of an ADHD diagnosis.

Our findings also relate to prior studies that evaluate the role of cognitive biases in diagnosis. Like ours, these studies highlight the subjectivity of medical diagnosis, in their case driven by cognitive biases. For example, one study of "left-digit bias" found that patients hospitalized with acute myocardial infarction just before their 80th birthday (i.e., those "in their 70s") received different treatments than patients hospitalized just after their 80th birthday (i.e., those "in their 80s") (Olenski et al. 2020). Another study of emergency room patients found that the diagnosis of pulmonary embolism was made more often when a physician had recently diagnosed a *different* patient with that condition, a phenomenon that would not occur if diagnosis was purely objective (Ly 2021). In a study of heuristics in labor and delivery units, obstetricians' decisions about a laboring patient's mode of delivery (vaginal versus cesarean section) were shown to be influenced by the complications the obstetrician encountered with the most recent prior patient they treated, highlighting once again the subjectivity involved in rapid, high-stakes bedside decisions (Singh 2021).

Our study has several limitations. First, despite the quasi-experimental study design, residual confounding is possible. However, there were no differences in measurable characteristics in children seen on Halloween compared with surrounding weekdays, no Halloween-associated increase in diagnosis of several neuropsychiatric conditions with diagnostic criteria that are less focused on hyperactive behavior, no differences in clinical complexity of children seen on Halloween, and no increase in ADHD diagnoses on another holiday (Valentine's Day), altogether suggesting that children seen in physicians' offices on Halloween do not start with greater baseline rates of ADHD. Second, our analysis is unable to determine whether Halloween day differences represent over-diagnosis of ADHD on Halloween or under-diagnosis on surrounding days; the evidence suggests both over- and under-diagnosis of ADHD may occur in various settings and within differing populations (Kazda et al. 2021b; Manos, Giuliano, and Geyer 2017; Morgan et al. 2014). Relatedly, our study does not speak to whether ADHD is overdiagnosed among children who are seen on Halloween or instead appropriately diagnosed. Third, this study does not pinpoint what specific factors drive differences on Halloween, though excitement related to the holiday and increased sugar intake are natural possibilities. Notably, our approach cannot distinguish between the potential impact of changes in child behavior on ADHD diagnosis versus different diagnostic thresholds being applied by clinicians, who themselves may be affected by the holiday. To the extent that Valentine's Day may be a more relevant distraction for adults than children, the absence of an increase in ADHD diagnosis on Valentine's Day may suggest the importance of changes in child behavior, rather than clinician behavior, on Halloween-associated ADHD diagnoses. Fourth, we analyzed a population of children covered by employer-sponsored health insurance, limiting generalizability to other populations.

In conclusion, in this quasi-experimental study of children with doctor's visits timed near Halloween, those seen and evaluated on Halloween day were more likely to be diagnosed with ADHD compared with children seen in the surrounding weekdays. Although our study does not speak to whether ADHD is overdiagnosed among children who are seen on Halloween or instead appropriately diagnosed, our findings highlight how external factors with subtle clinical impact on behavior may influence the diagnosis of ADHD or other conditions with subjective diagnostic criteria.

REFERENCES

Adamis, Dimitrios, Caroline Flynn, Margo Wrigley, Blánaid Gavin, and Fiona McNicholas. 2022. "ADHD in Adults: A Systematic Review and Meta-Analysis of Prevalence Studies in Outpatient Psychiatric Clinics." *Journal of Attention Disorders* 26 (12):1523-1534. doi: 10.1177/10870547221085503.

American Psychiatric Association. 2013. *Diagnostic and statistical manual of mental disorders (DSM-5®)*: American Psychiatric Pub.

Arnold, L. E., P. Hodgkins, J. Kahle, M. Madhoo, and G. Kewley. 2020. "Long-Term Outcomes of ADHD: Academic Achievement and Performance." *J Atten Disord* 24 (1):73-85. doi: 10.1177/1087054714566076.

Bitsko, R. H., A. H. Claussen, J. Lichstein, L. I. Black, S. E. Jones, M. L. Danielson, J. M. Hoenig, S. P. Davis Jack, D. J. Brody, S. Gyawali, M. J. Maenner, M. Warner, K. M. Holland, R. Perou, A. E. Crosby, S. J. Blumberg, S. Avenevoli, J. W. Kaminski, R. M. Ghandour, and Contributor. 2022. "Mental Health Surveillance Among Children - United States, 2013-2019." *MMWR Suppl* 71 (2):1-42. doi: 10.15585/mmwr.su7102a1.

Centers for Disease Control and Prevention. 1997. "Childhood pedestrian deaths during Halloween--United States, 1975-1996." *MMWR. Morbidity and mortality weekly report* 46 (42):987-990.

Chang, Zheng, Patrick D. Quinn, Kwan Hur, Robert D. Gibbons, Arvid Sjölander, Henrik Larsson, and Brian M. D'Onofrio. 2017. "Association Between Medication Use for Attention-Deficit/Hyperactivity Disorder and Risk of Motor Vehicle Crashes." *JAMA Psychiatry* 74 (6):597. doi: 10.1001/jamapsychiatry.2017.0659.

Cochrane Collaboration. 2020. "The standardized mean difference." https://handbook-5-1.cochrane.org/chapter_9/9_2_3_2_the_standardized_mean_difference.htm.

Coker, T. R., M. N. Elliott, S. L. Toomey, D. C. Schwebel, P. Cuccaro, S. Tortolero Emery, S. L. Davies, S. N. Visser, and M. A. Schuster. 2016. "Racial and Ethnic Disparities in ADHD Diagnosis and Treatment." *Pediatrics* 138 (3):e20160407-e20160407. doi: 10.1542/peds.2016-0407.

Coussens, Stephen. 2018. "Behaving Discretely: Heuristic Thinking in the Emergency Department." *SSRN Electronic Journal*. doi: 10.2139/ssrn.3743423.

Elder, T. E. 2010. "The importance of relative standards in ADHD diagnoses: evidence based on exact birth dates." *J Health Econ* 29 (5):641-56. doi: 10.1016/j.jhealeco.2010.06.003.

Evans, W. N., M. S. Morrill, and S. T. Parente. 2010. "Measuring inappropriate medical diagnosis and treatment in survey data: The case of ADHD among school-age children." *J Health Econ* 29 (5):657-73. doi: 10.1016/j.jhealeco.2010.07.005.

Fuchs, Thomas. 2010. "Subjectivity and Intersubjectivity in Psychiatric Diagnosis." *Psychopathology* 43 (4):268-274. doi: 10.1159/000315126.

Furzer, J., E. Dhuey, and A. Laporte. 2022. "ADHD misdiagnosis: Causes and mitigators." *Health Econ* 31 (9):1926-1953. doi: 10.1002/hec.4555.

Haeck, Catherine, Geneviève Lefebvre, Pierre Lefebvre, and Philip Merrigan. 2023. "Surdiagnostic du TDAH au Québec: Impact de l'âge d'entrée à l'école, différences régionales et coûts sociaux et économiques." *2023RP-08, Projects Reports, CIRANO*. doi: 10.54932/dtdb7162.

Healthcare Cost and Utilization Project. 2017. "Elixhauser Comorbidity Software." Agency for Healthcare Research and Quality. https://www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp.

Kazda, Luise, Katy Bell, Rae Thomas, Kevin Mcgeechan, Rebecca Sims, and Alexandra Barratt. 2021a. "Overdiagnosis of Attention-Deficit/Hyperactivity Disorder in Children and Adolescents." *JAMA Network Open* 4 (4):e215335. doi: 10.1001/jamanetworkopen.2021.5335.

Kazda, Luise, Katy Bell, Rae Thomas, Kevin McGeechan, Rebecca Sims, and Alexandra Barratt. 2021b. "Overdiagnosis of Attention-Deficit/Hyperactivity Disorder in Children and Adolescents: A Systematic Scoping Review." *JAMA Network Open* 4 (4):e215335-e215335. doi: 10.1001/jamanetworkopen.2021.5335.

Layton, T. J., M. L. Barnett, T. R. Hicks, and A. B. Jena. 2018. "Attention Deficit-Hyperactivity Disorder and Month of School Enrollment." *N Engl J Med* 379 (22):2122-2130. doi: 10.1056/NEJMoa1806828.

Ly, D. P. 2021. "The Influence of the Availability Heuristic on Physicians in the Emergency Department." *Ann Emerg Med* 78 (5):650-657. doi: 10.1016/j.annemergmed.2021.06.012.

Manos, Michael J., Kimberly Giuliano, and Eric Geyer. 2017. "ADHD: Overdiagnosed and overtreated, or misdiagnosed and mistreated?" *Cleveland Clinic Journal of Medicine* 84 (11):873-880. doi: 10.3949/ccjm.84a.15051.

Mantantzis, K., F. Schlaghecken, S. I. Sunram-Lea, and E. A. Maylor. 2019. "Sugar rush or sugar crash? A meta-analysis of carbohydrate effects on mood." *Neurosci Biobehav Rev* 101:45-67. doi: 10.1016/j.neubiorev.2019.03.016.

Milich, R., and W. E. Pelham. 1986. "Effects of sugar ingestion on the classroom and playground behavior of attention deficit disordered boys." *J Consult Clin Psychol* 54 (5):714-8. doi: 10.1037//0022-006x.54.5.714.

Morgan, P. L., M. M. Hillemeier, G. Farkas, and S. Maczuga. 2014. "Racial/ethnic disparities in ADHD diagnosis by kindergarten entry." *J Child Psychol Psychiatry* 55 (8):905-13. doi: 10.1111/jcpp.12204.

National Academy of Medicine. 2015. Improving diagnosis in health care. Washington, D.C.: National Academies of Science, Engineering, and Medicine.

National Oceanic and Atmospheric Administration. 2024. "Global Historical Climatology Network." U.S. Department of Commerce, accessed 2024. https://www.drought.gov/data-maps-tools/global-historical-climatology-network-ghcn.

Nordgaard, Julie, Louis A. Sass, and Josef Parnas. 2012. "The psychiatric interview: validity, structure, and subjectivity." *European Archives of Psychiatry and Clinical Neuroscience* 263 (4):353-364. doi: 10.1007/s00406-012-0366-z.

Olenski, A. R., A. Zimerman, S. Coussens, and A. B. Jena. 2020. "Behavioral Heuristics in Coronary-Artery Bypass Graft Surgery." *N Engl J Med* 382 (8):778-779. doi: 10.1056/NEJMc1911289.

Schwandt, Hannes, and Amelie Wuppermann. 2016. "The youngest get the pill: ADHD misdiagnosis in Germany, its regional correlates and international comparison." *Labour Economics* 43:72-86. doi: https://doi.org/10.1016/j.labeco.2016.05.018.

Shaw, M., P. Hodgkins, H. Caci, S. Young, J. Kahle, A. G. Woods, and L. E. Arnold. 2012. "A systematic review and analysis of long-term outcomes in attention deficit hyperactivity

disorder: effects of treatment and non-treatment." *BMC Med* 10:99. doi: 10.1186/1741-7015-10-99.
Singh, M. 2021. "Heuristics in the delivery room." *Science* 374 (6565):324-329. doi: 10.1126/science.abc9818.
Staples, John A., Candace Yip, and Donald A. Redelmeier. 2019. "Pedestrian Fatalities Associated With Halloween in the United States." *JAMA Pediatrics* 173 (1):101. doi: 10.1001/jamapediatrics.2018.4052.
U.S. Bureau of Economic Analysis. 2011. "CAINC1 Personal Income Summary: Personal Income, Population, Per Capita Personal Income.".
U.S. Census Bureau. 2011. American Community Survey "B15003 Educational Attainment for the Population 25 Years and Over".
Visser, S. N., M. L. Danielson, M. L. Wolraich, M. H. Fox, S. D. Grosse, L. A. Valle, J. R. Holbrook, A. H. Claussen, and G. Peacock. 2016. "Vital Signs: National and State-Specific Patterns of Attention Deficit/Hyperactivity Disorder Treatment Among Insured Children Aged 2-5 Years - United States, 2008-2014." *MMWR Morb Mortal Wkly Rep* 65 (17):443-50. doi: 10.15585/mmwr.mm6517e1.
Volkow, N. D., and J. M. Swanson. 2013. "Clinical practice: Adult attention deficit-hyperactivity disorder." *N Engl J Med* 369 (20):1935-44. doi: 10.1056/NEJMcp1212625.
Wender, Esther H., and Mary V. Solanto. 1991. "Effects of Sugar on Aggressive and Inattentive Behavior in Children With Attention Deficit Disorder With Hyperactivity and Normal Children." *Pediatrics* 88 (5):960-966. doi: 10.1542/peds.88.5.960.
Whitely, M., M. Raven, S. Timimi, J. Jureidini, J. Phillimore, J. Leo, J. Moncrieff, and P. Landman. 2019. "Attention deficit hyperactivity disorder late birthdate effect common in both high and low prescribing international jurisdictions: a systematic review." *J Child Psychol Psychiatry* 60 (4):380-391. doi: 10.1111/jcpp.12991.
Wolraich, M. L., J. F. Hagan, Jr., C. Allan, E. Chan, D. Davison, M. Earls, S. W. Evans, S. K. Flinn, T. Froehlich, J. Frost, J. R. Holbrook, C. U. Lehmann, H. R. Lessin, K. Okechukwu, K. L. Pierce, J. D. Winner, W. Zurhellen, Children Subcommittee On, and Disorder Adolescents With Attention-Deficit/Hyperactive. 2019. "Clinical Practice Guideline for the Diagnosis, Evaluation, and Treatment of Attention-Deficit/Hyperactivity Disorder in Children and Adolescents." *Pediatrics* 144 (4):e20192528. doi: 10.1542/peds.2019-2528.
Wolraich, M. L., S. D. Lindgren, P. J. Stumbo, L. D. Stegink, M. I. Appelbaum, and M. C. Kiritsy. 1994. "Effects of diets high in sucrose or aspartame on the behavior and cognitive performance of children." *N Engl J Med* 330 (5):301-7. doi: 10.1056/NEJM199402033300501.
Wolraich, M. L., D. B. Wilson, and J. W. White. 1995. "The effect of sugar on behavior or cognition in children. A meta-analysis." *JAMA* 274 (20):1617-21. doi: 10.1001/jama.1995.03530200053037.
Worsham, C. M., J. Woo, A. B. Jena, and M. L. Barnett. 2021. "Adverse Events And Emergency Department Opioid Prescriptions In Adolescents." *Health Affairs* 40 (6):970-978. doi: 10.1377/hlthaff.2020.01762.
Worsham, C., J. Woo, and A. B. Jena. 2020. "Birth Month and Influenza Vaccination in Children." *N Engl J Med* 383 (2):184-185. doi: 10.1056/NEJMc2005928.
Xu, Guifeng, Lane Strathearn, Buyun Liu, Binrang Yang, and Wei Bao. 2018. "Twenty-Year Trends in Diagnosed Attention-Deficit/Hyperactivity Disorder Among US Children and

Adolescents, 1997-2016." *JAMA Network Open* 1 (4):e181471. doi: 10.1001/jamanetworkopen.2018.1471.

Zhang, H., and A. Khan. 2020. "Risk of preventable injuries associated with Halloween." *Public Health* 189:94-96. doi: 10.1016/j.puhe.2020.10.014.

Table 1: International Classification of Diseases Definitions for Outcome Variables

Outcome	ICD-9	ICD-10
ADHD	314.01 314.00	F90.0 F90.1 F90.2 F90.8 F90.9
Autism and Asperger's Syndrome	299.00 299.01 299.80 299.81	F84.0 F84.1 F84.5
Personality Disorders	301	F60
Eating Disorders	307.5	F50

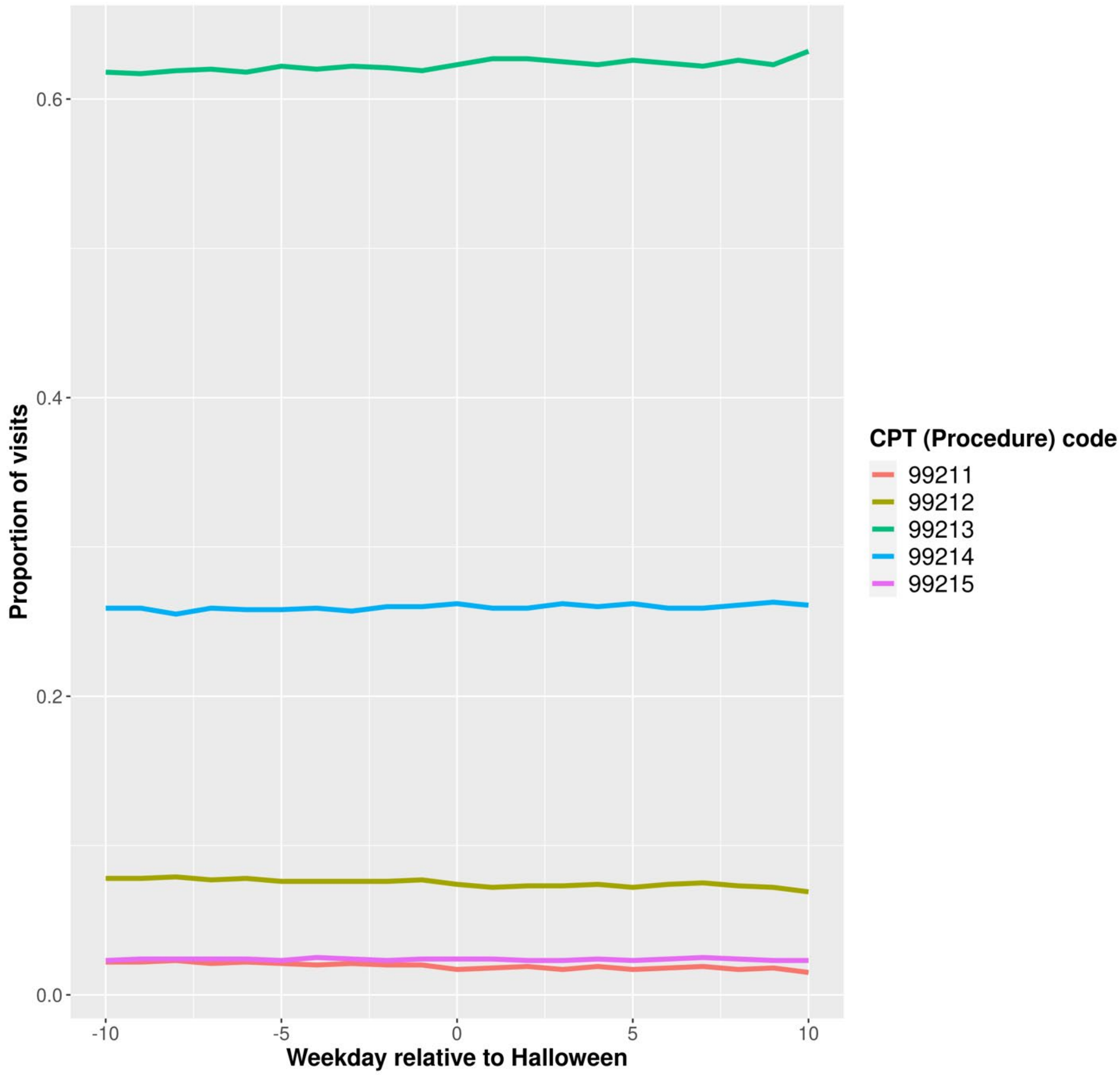
Notes: ADHD = attention deficit hyperactivity syndrome; ICD = International Classification of Diseases.

Table 2: Study Population

	Visit on Halloween	Visit on ±10 Weekdays Surrounding Halloween	Overall	Standardized Mean Difference
	n = 406,919	n = 10,760,387	n = 11,167,306	
Patient Characteristics				
Age in years, mean (SD)	12.10 (4.09)	11.72 (4.06)	11.73 (4.07)	0.06
Male sex, n (%)	210,082 (51.6)	5,696,098 (52.9)	5,906,180 (52.9)	0.02
Total Elixhauser comorbidities, mean (SD)	0.68 (1.01)	0.67 (0.99)	0.67 (0.99)	< 0.01
Diabetes without complications, n (%)	4,153 (1.0)	105,388 (1.0)	109,541 (1.0)	< 0.01
Diabetes with complications, n (%)	1,714 (0.4)	41,294 (0.4)	43,008 (0.4)	< 0.01
Obesity, n (%)	17,218 (4.2)	431,046 (4.0)	448,264 (4.0)	< 0.01
Prior pulmonary disease, n (%)	94,369 (23.2)	2,506,378 (23.3)	2,600,747 (23.3)	< 0.01
Depression, n (%)	56,606 (13.9)	1,551,903 (14.4)	1,608,509 (14.4)	0.01
Annual ED visits during study period, mean (SD)	0.28 (0.75)	0.26 (0.71)	0.26 (0.71)	0.02
Annual office visits during study period, mean (SD)	14.28 (22.04)	14.23 (20.95)	14.23 (20.99)	< 0.01
Annual preventive care visits during study period, mean (SD)	4.60 (5.02)	4.59 (4.81)	4.59 (4.82)	< 0.01
Annual hospitalizations during study period, mean (SD)	0.05 (0.40)	0.05 (0.36)	0.05 (0.36)	< 0.01
Number of siblings diagnosed with ADHD, mean (SD)	0.03 (0.20)	0.03 (0.20)	0.03 (0.20)	< 0.01
Number of parents diagnosed with ADHD, mean (SD)	0.05 (0.24)	0.05 (0.24)	0.05 (0.24)	< 0.01
Sibling Characteristics				
Total Elixhauser comorbidities, mean (SD)	0.51 (0.85)	0.50 (0.85)	0.50 (0.85)	< 0.01
Annual ED visits during study period, mean (SD)	0.25 (0.56)	0.24 (0.54)	0.24 (0.54)	0.01
Annual office visits during study period, mean (SD)	10.97 (15.69)	11.00 (14.91)	11.00 (14.94)	0.01
Annual preventive care visits during study period, mean (SD)	4.20 (3.91)	4.23 (3.77)	4.23 (3.78)	< 0.01
Annual hospitalizations during study period, mean (SD)	0.05 (0.26)	0.04 (0.24)	0.04 (0.24)	< 0.01
Parent Characteristics				
Total Elixhauser comorbidities, mean (SD)	1.81 (1.76)	1.79 (1.75)	1.79 (1.75)	< 0.01
Annual ED visits during study period, mean (SD)	0.19 (0.58)	0.19 (0.57)	0.19 (0.57)	< 0.01
Annual office visits during study period, mean (SD)	8.48 (10.02)	8.64 (10.05)	8.64 (10.05)	0.01
Annual preventive care visits during study period, mean (SD)	3.76 (3.95)	3.78 (3.83)	3.78 (3.83)	< 0.01
Annual hospitalizations during study period, mean (SD)	0.05 (0.23)	0.05 (0.22)	0.05 (0.23)	< 0.01

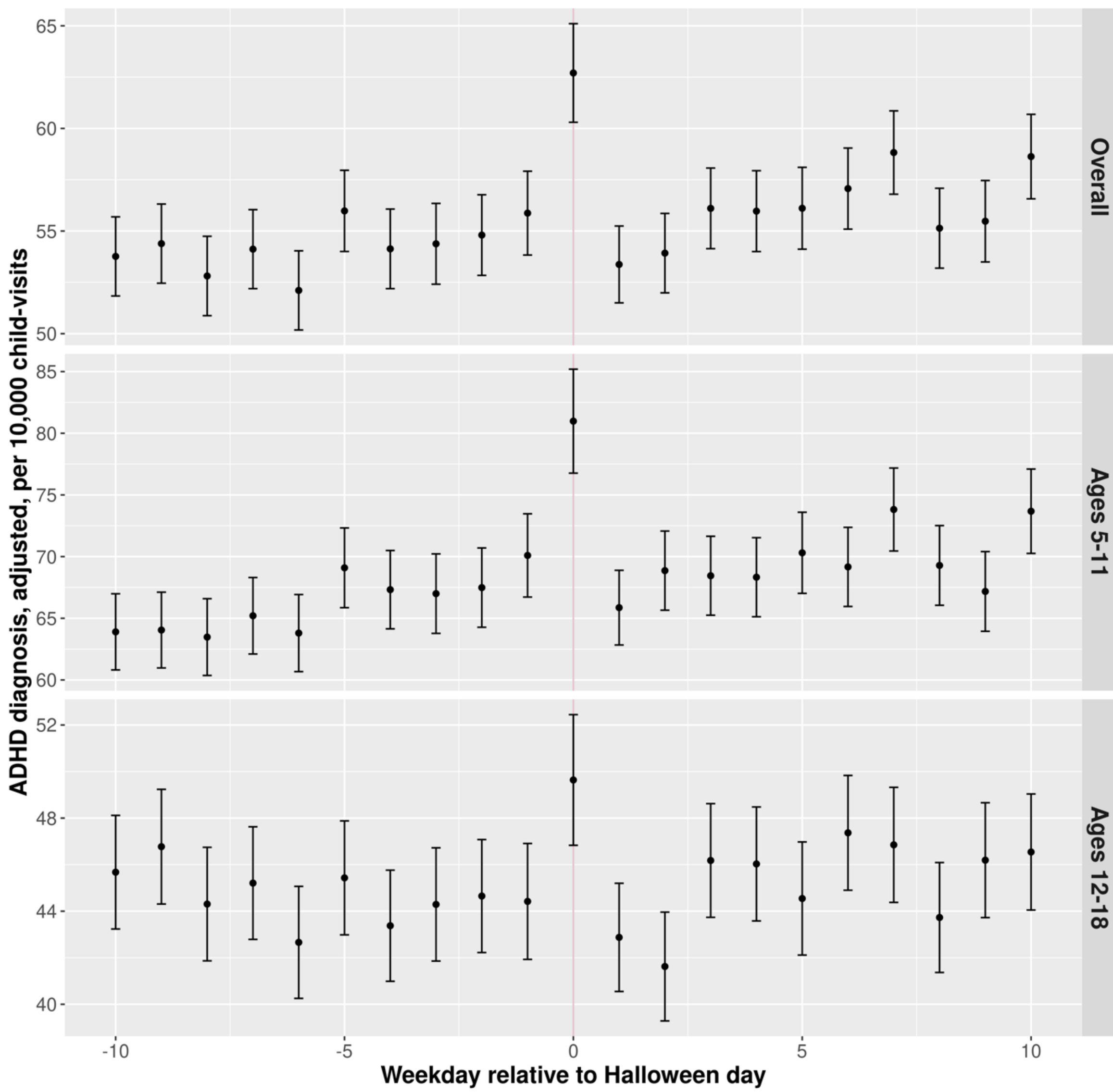
Notes: SD = standard deviation. ED = emergency department. ADHD = attention deficit hyperactivity disorder. Sample sizes are in child-visits.

Figure 1: E&M Visit Complexity by Weekday Relative to Halloween



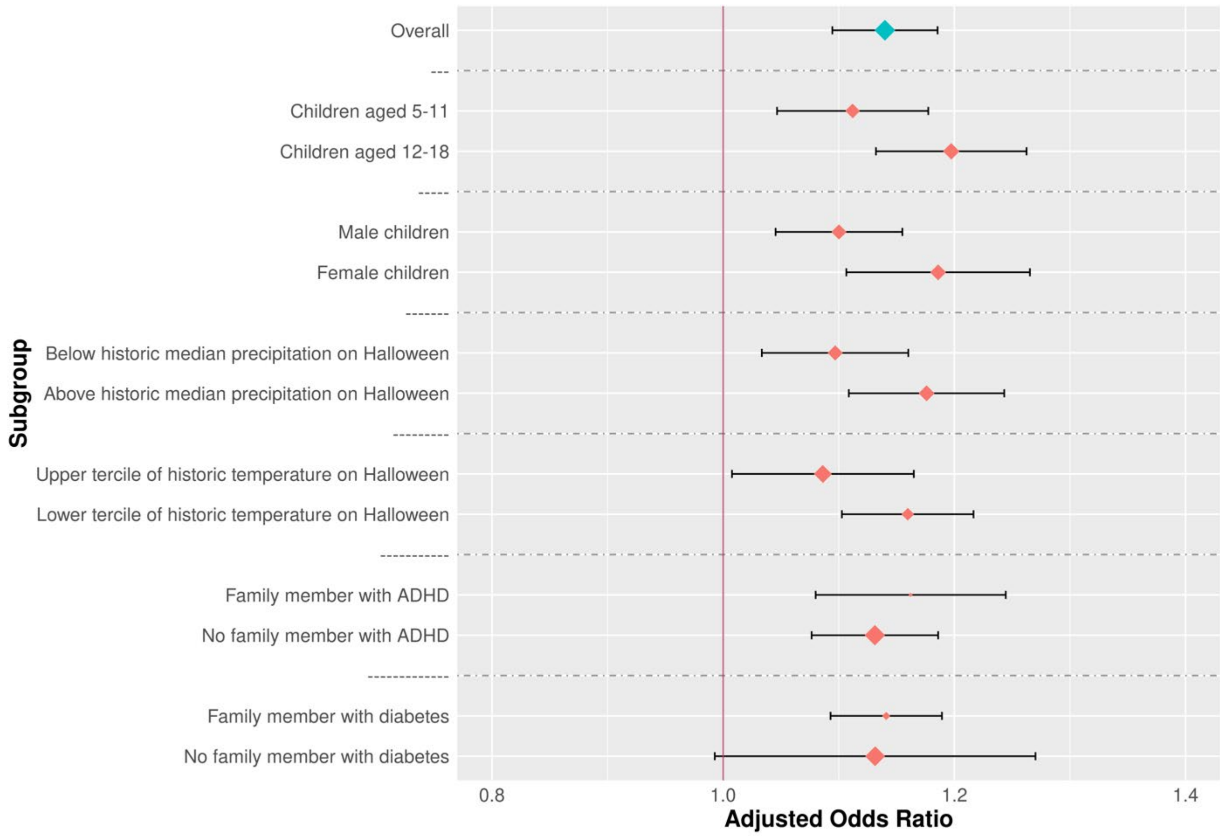
Notes: E&M = evaluation and management; CPT = Current Procedural Terminology. This plot shows the proportion of visits on each weekday relative to Halloween (day 0) that were billed under E&M CPT codes 99211-99215, with 99211 corresponding to the lowest complexity visit and 99215 the highest. The purpose of this analysis was to evaluate for differences in complexity of patients presenting on Halloween compared to the surrounding weekdays; there do not appear to be any meaningful differences in billed complexity on Halloween versus non-Halloween days.

Figure 2: Changes in ADHD Diagnosis around Halloween



Notes: ADHD = attention deficit hyperactivity disorder. Bars reflect 95% confidence intervals.

Figure 3: Adjusted Odds Ratios of ADHD Diagnosis on Halloween vs. Surrounding Weekdays, by Subgroup



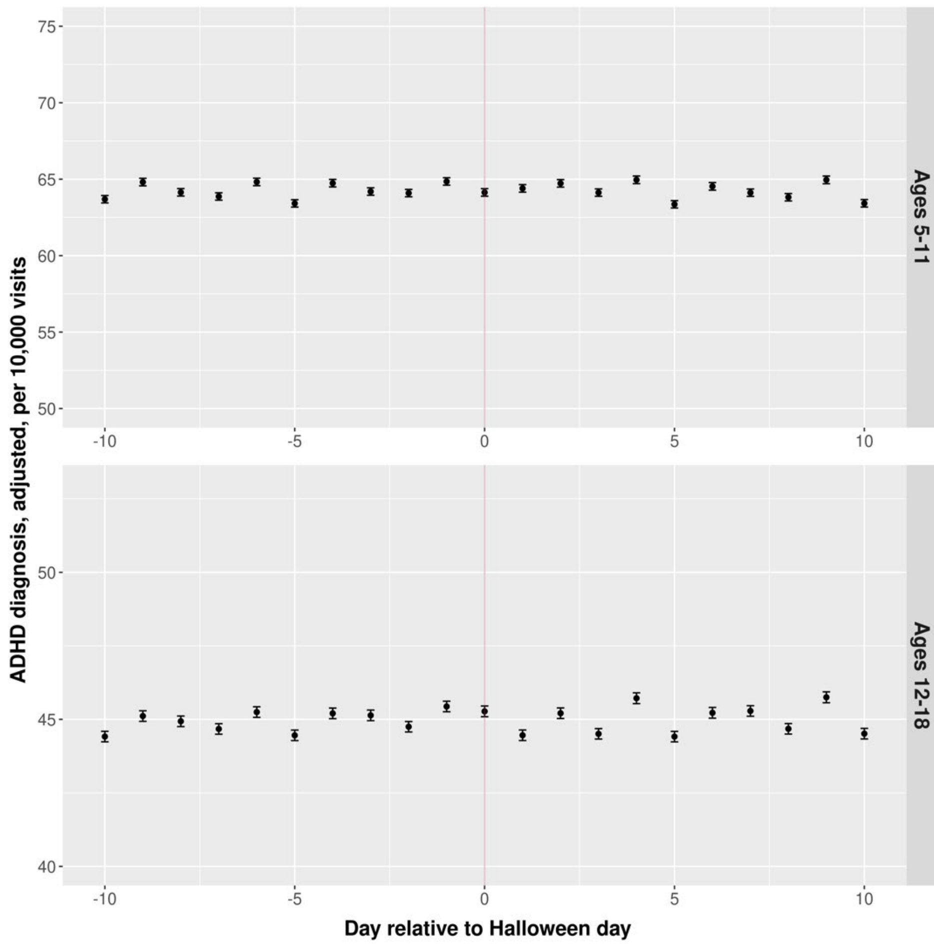
Notes: ADHD = attention deficit hyperactivity disorder. Bars reflect 95% confidence intervals.

Table 3: Adjusted Odds Ratios for ADHD Diagnosis on Halloween vs. Surrounding Weekdays, by Subgroup

	Odds Ratio [95% CI]	**p-value**
Overall	1.14 [1.09-1.19]	< 0.01
Stratified by Age		
Ages 5-11	1.11 [1.05-1.18]	< 0.01
Ages 12-18	1.20 [1.13-1.26]	< 0.01
Stratified by Sex		
Male	1.10 [1.05-1.16]	< 0.01
Female	1.19 [1.11-1.27]	< 0.01
Stratified by MSA-day Temperature		
Upper Tercile of Historic Temperature	1.09 [1.01-1.17]	0.03
Lower Tercile of Historic Temperature	1.16 [1.10-1.22]	< 0.01
Stratified by MSA-day Precipitation		
Above Median Historic Precipitation	1.18 [1.11-1.24]	< 0.01
Below Median Historic Precipitation	1.10 [1.03-1.16]	< 0.01
Stratified by Household Diabetes Status		
Household Member with Diabetes	1.13 [1.00-1.28]	0.05
No Household Member with Diabetes	1.14 [1.09-1.19]	< 0.01
Stratified by Family History of ADHD		
Parent(s) with ADHD Diagnosis	1.16 [1.08-1.24]	< 0.01
Parent(s) without ADHD Diagnosis	1.13 [1.08-1.19]	< 0.01

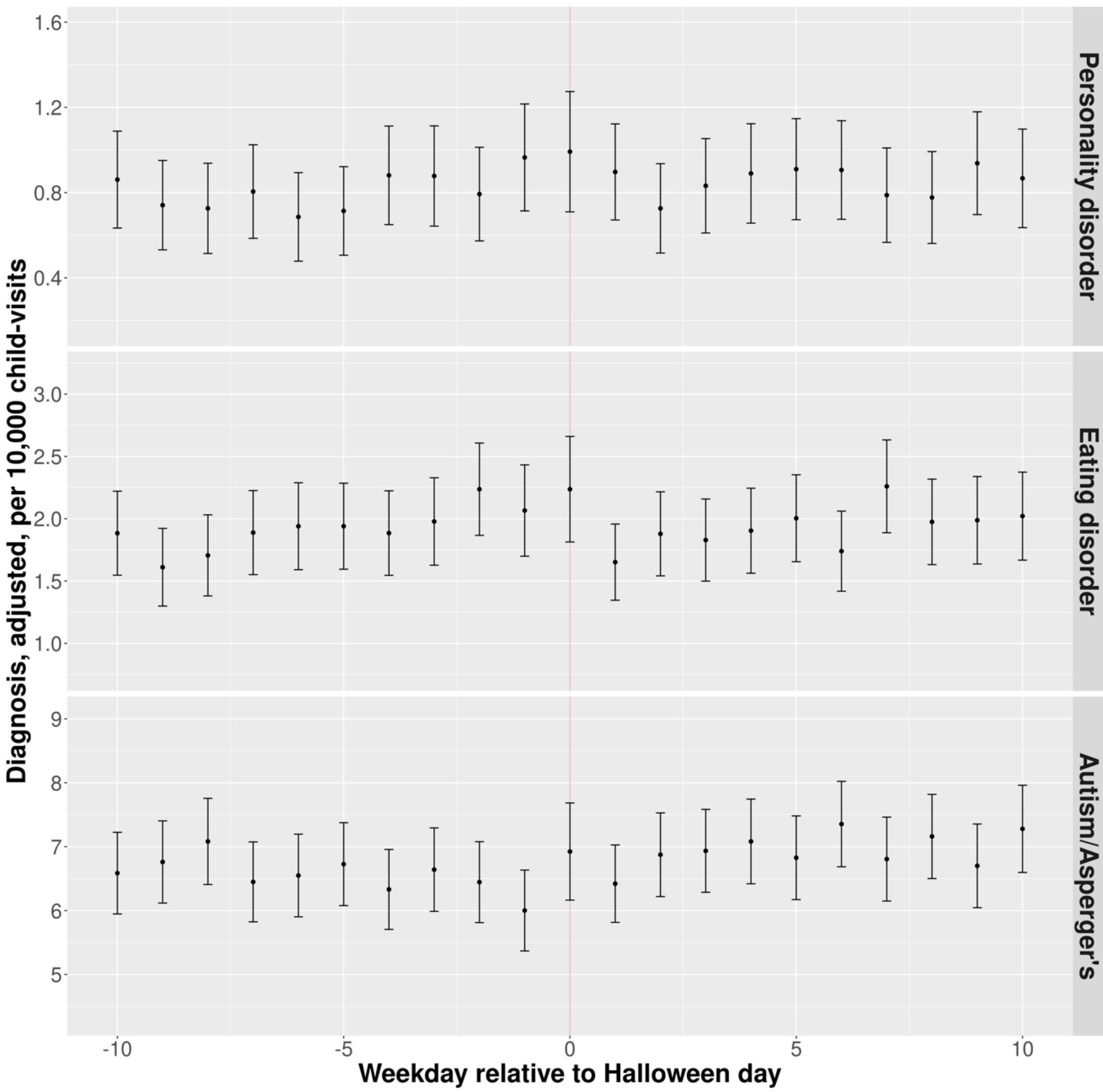
Notes: ADHD = attention deficit hyperactivity disorder; CI = confident interval; MSA = metropolitan statistical area. Odds ratios represent rate of new ADHD diagnosis on Halloween versus ±10 surrounding weekdays, adjusting for baseline rate of diagnosis among all other days, day of week, and patient and family clinical and healthcare utilization covariates.

Figure 4: Predicted Rate of New ADHD Diagnosis by Weekday Relative to Halloween



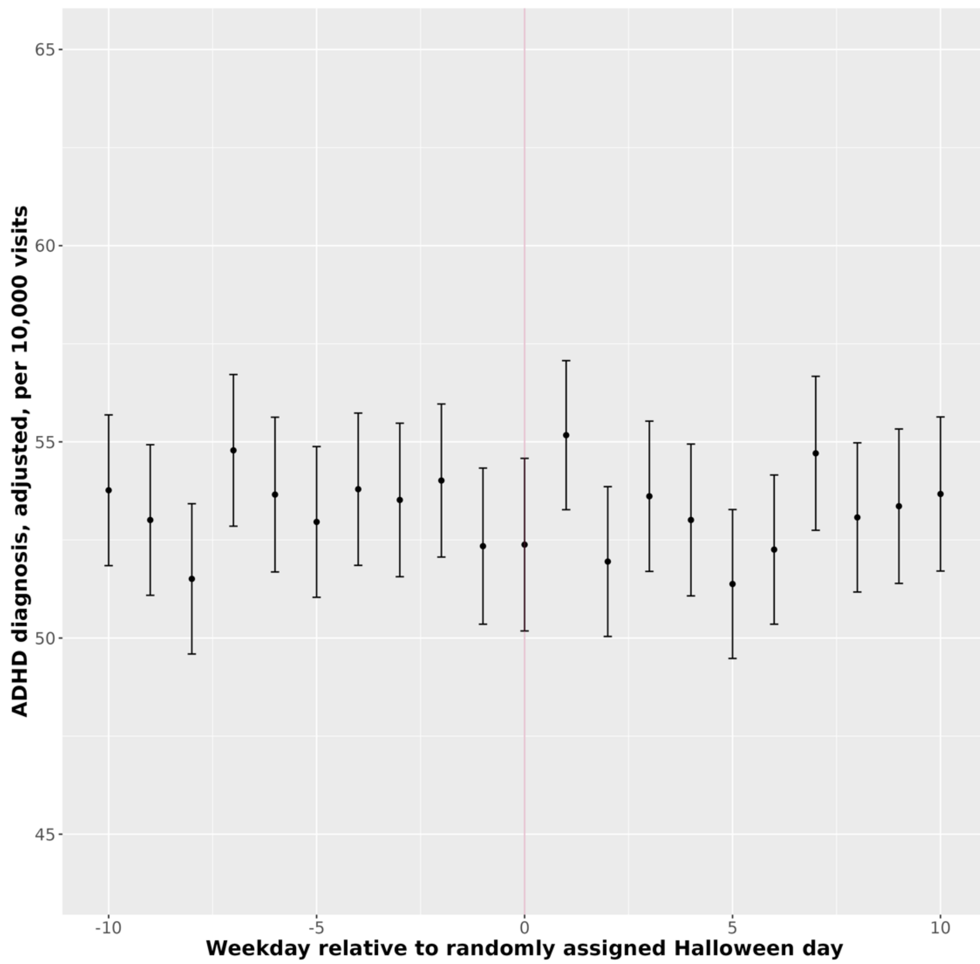
Notes: ADHD = attention deficit hyperactivity disorder. Predictions are based on a logistic regression model including all covariates in the primary analysis, excluding Halloween relative day covariates. The purpose of this analysis is to assess for meaningful differences in baseline risk of ADHD diagnosis as predicted by clinical covariates on Halloween as compared with other days. Vertical axis scales are matched with Figure 1 of the primary manuscript.

Figure 5: Adjusted Rate of other Neuropsychiatric Conditions by Weekday Relative to Halloween



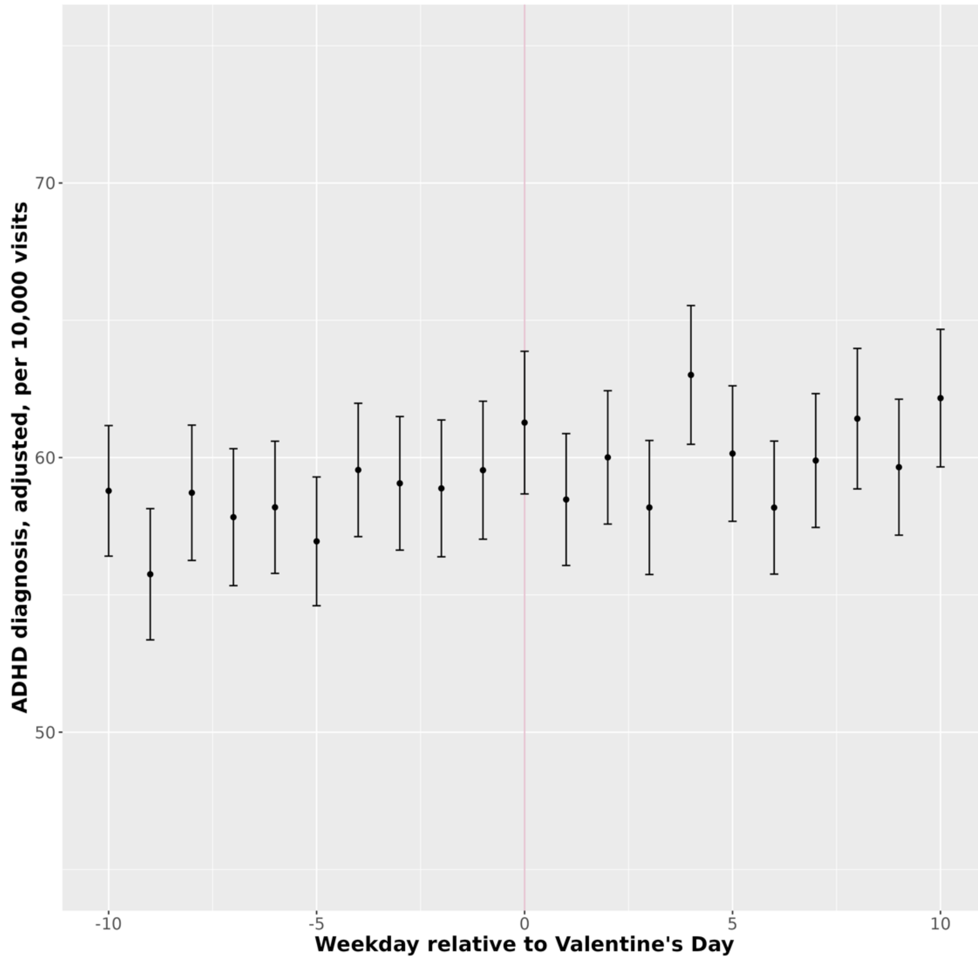
Notes: The horizontal axis represents weekdays relative to Halloween (day 0). The vertical axis in top panel shows the diagnosis rate for personality disorder (top panel), eating disorder (middle panel), or autism/Asperger's syndrome (bottom panel), adjusted for the same covariates as in the primary analysis. The purpose of these falsification analyses was to assess for selection bias in children who are seen in doctor's offices on Halloween, by studying Halloween-day differences in rates of neuropsychiatric diagnoses more broadly; the absence of Halloween-day differences in these analyses suggests that selection bias does not explain our main findings.

Figure 6: Simulated Probability of ADHD Diagnosis Surrounding Randomly Selected Days In Lieu of Halloween



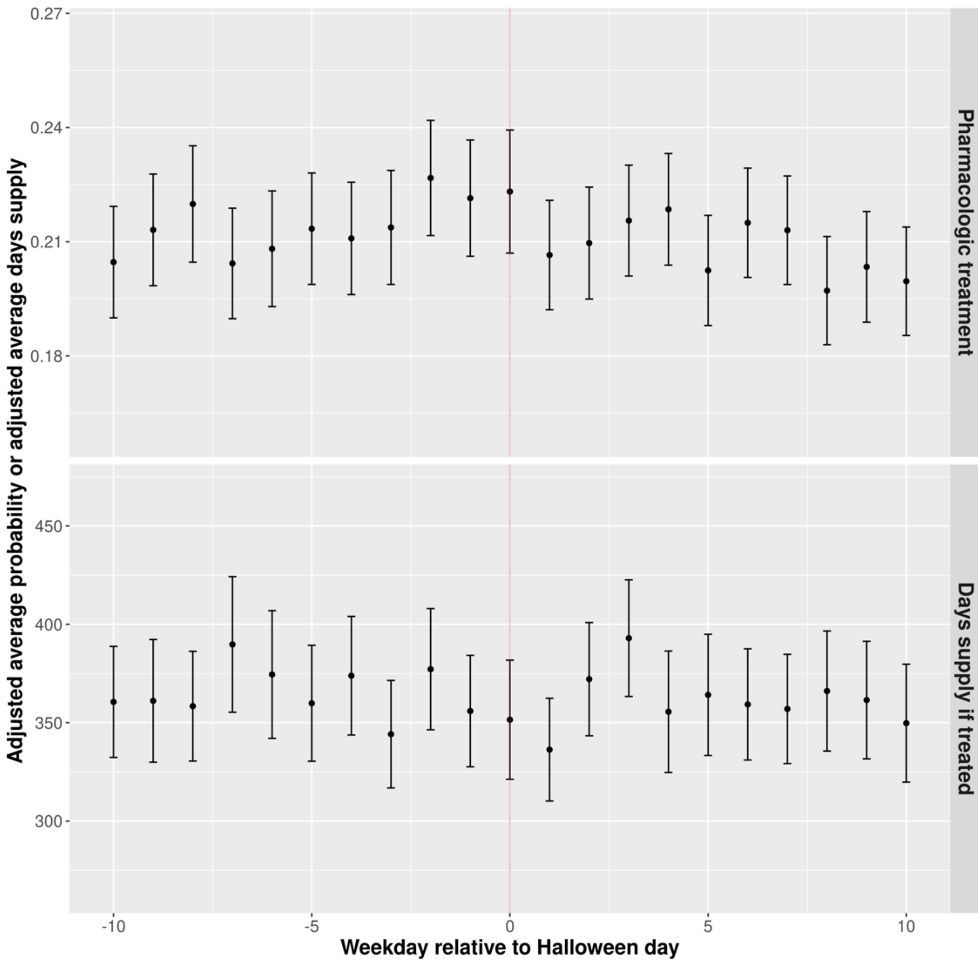
Notes: ADHD = attention deficit hyperactivity disorder. Plot displays average results of a simulation repeating the primary analysis 1,000 times using random weekdays in lieu of Halloween day, an analysis conducted to evaluate whether our main finding of increased ADHD diagnosis on Halloween is due to chance.

Figure 7: Adjusted Rate of New ADHD Diagnosis by Weekday Relative to Valentine's Day



Notes: ADHD = attention deficit hyperactivity disorder. Predictions are based on a logistic regression model including all covariates in the primary analysis, with Valentine's Day (February 14th) substituted for Halloween as Day 0. The purpose of this analysis was to evaluate whether the Halloween day differences seen in the primary analysis may be due to selection bias in patients who are seen in doctor's offices on holidays more generally. We therefore assessed for a broader effect on ADHD diagnosis that might be seen on other "soft" holidays, like Valentine's Day, where doctor's offices remain open. The absence of Valentine's Day differences in ADHD diagnosis rates is consistent with a Halloween-specific effect and suggests that selection bias does not explain our main findings.

Figure 8: Pharmacologic Treatment for ADHD, by Weekday Relative to Halloween



Notes: ADHD = attention deficit hyperactivity disorder. The horizontal axis represents weekdays relative to Halloween (day 0). The vertical axis in top panel shows the proportion of patients prescribed a stimulant among those newly diagnosed with ADHD, adjusted for the same covariates as in the primary analysis. The vertical axis of the bottom panel shows the mean number of days of stimulant prescribed (across the entire follow up period for a given patient) among patients with a new ADHD diagnosis who were prescribed a stimulant, adjusting for the same covariates as in the primary analysis. The purpose of these analyses was to evaluate for differences in stimulant prescribing patterns for ADHD diagnoses made on Halloween as compared with surrounding weekdays.